

A REVIEW ON HYDROPONICS AS A VERSATILE SYSTEM TO CULTIVATE ENDANGERED MEDICINAL PLANTS

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ABSTRACT

An alarming demand for the medicinal plants has resulted in the drastic depletion of existing wild populations and opens up an opportunity for the profitable cultivation. Medicinal plants are extensively cultivated for its economic value and to satisfy the increasing demand for the natural remedies. Varieties of species are usually grown in an open field aiming at the variability in biomass production and bioactive principles. Regardless, in the recent years, a substantial decline has been evidently witnessed in the contribution by the sector of agriculture, most importantly due to the decrease in per capita land availability. Hence, hydroponic technology may be successfully employed to yield high-standard plant materials throughout the year with respect to control over the growing conditions and also to promote secondary metabolism by targeted manipulation of desired nutrient. A wide range of modern hydroponic systems have been employed by the researchers across the globe as one of the standard methods for the commercial production. Provided the results are promising as it tends to be the improved space and water conservation method in recent times. Thus, this review aims to study the possible applications for the monitoring and control of Hydroponic setups for the growth of endangered medicinal plants.

Keywords: *hydroponic systems, cultivation, secondary metabolism, nutrient.*

1.INTRODUCTION

Nature has provided infinite remedies to cure various diseases that threaten human life. It has been estimated that over 90% of the world population currently relies upon the raw herbs and unrefined extracts as medicines. India being a country of extremely rich plant biodiversity,

country's major population depends upon the Ayurvedic medicines. Hence medicinal plants with extensive bioactive compounds are the major sources of several modern medicines of the present day and are chiefly used by pharmaceutical industries. Thus the consumption of the plant based medicine is pandemic and tends to increase rapidly. The 20th century experienced the expansion of agro-based innovations due to the onset of various scientific practices and technologies. But then the supply of wild medicinal plant stocks is declining and highly valued species are becoming inaccessible due to extinctions and rapidly rising market prices^[1]. On the other hand, human civilization and population explosion has begun to exploit various resources that play essential role in agriculture such as water, land etc^[2]. Eventually an expeditive industrialisation has also drastically affected the soil fertility. Further Harvesting from the wild varieties, the main source of raw material, is thereby causes a remarkable loss of genetic diversity and habitat destruction. Domestic cultivation is a viable alternative and it offers the opportunity to overcome the problems which are inherent in herbal extracts: misidentification, genetic and phenotypic variability, extract variability and instability, toxic components and contaminants. And in order to surmount these conflicts, new trends are being developed by the scientists across the globe in an effective manner. Specifically, the use of controlled environments can help in overcoming the cultivation difficulties and could be a means to manipulate phenotypic variation in bioactive compounds and toxins^[3]. The agronomic and medicinal traits could be improved by conventional plant breeding methods by the application of molecular marker assisted selection. Tissue culture and the genetic transformation have been significantly used in the recent past. However, the conventional methods of raising up the crops are difficult as they tend to consume large space, lot of labour and enormous volume of water. And hence 'Hydroponics', otherwise called as Aeroponics or soil less culture may be followed. The term Hydroponics traces its origin from the Greek words *hydro* ' and *ponos* ' that means Water and Labour respectively^[4]. It refers to the method of growing plants using mineral nutrient solutions, without soil^[4]. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium containing perlite, gravel, or mineral wool. This system also facilitates to face the challenges of climate change and also helps in production system management for efficient utilization of natural resources and mitigating malnutrition^[5]. By the end of 19th century, many automated and computerized hydroponics farms were established around the world. In traditional methods, the food crops and the field medicinal herbs and plants were grown together, as the herbs which are of high medicinal values provided permanent cure but

take a longer period of time. The conventional medicines not being a permanent cure, the people of the recent past have started practising the folk herbal medicines back, which in turn has created a drastic demand for the herbs among the markets. Hence the application of hydroponics for the development of medicinal plants can do some reliable miracles in the days to come.

2. AVAILABLE TECHNIQUES FOR THE SOIL LESS CULTURE

There are numbers of hydroponic/soil-less culture techniques which are available. Nonetheless, the factors such as Space and other necessary resources, desired productivity, availability of suitable growing medium and expected quality of the product viz., colour, appearance, pesticide content are to be significantly examined. Provided the techniques are classified as:

Liquid Hydroponics method comprises the plants grown in a solution culture that have their roots suspended directly in a nutrient solution. It can further be classified into^[6]

i) Circulating methods (closed system)/ Continuous flow solution culture

- a) Nutrient film technique (NFT)
- b) Deep flow technique (DFT)

Flowing solution culture systems can provide a consistent nutrient environment for roots. They are highly amenable to automatic control but are subject to rapid plant desiccation if the flow of solution stops for any reason. Thus frequent attention is required.

ii) Non-circulating method (open systems)/ Static solution culture

- a) Root dipping technique
- b) Floating technique
- c) Capillary action technique

Here suitable specific vessels for static systems include polythene beakers, pots, glass jar and containers lined with black polythene film.

iii) Media Culture Technique

A solid medium is used for the growth of the plant in the media culture method and is named for the type of inner medium. e.g. sand culture, gravel culture or rock wool culture. Significantly there are two main variations for each medium viz., sub-irrigation and top-irrigation. However, they are classified as follows:

- 1. Hanging bag technique
- 2. Grow bag technique
- 3. Trench or trough technique

4. Pot technique

iv) Aeroponics

Aeroponics being a method of growing plants anchored in holes in Styrofoam panels with their roots suspended in air beneath the panel. The aeroponics culture is usually practiced in protected structures and is suitable for low leafy vegetables like lettuce, spinach, etc. There are two techniques under this group:

1. Root mist technique
2. Fog feed technique

3. MEDICINAL PLANTS THAT ARE GROWN ON HYDROPONICS

India is a country of rich plant biodiversity of which many are medicinally very useful. In the recent past, over-exploitation has drastically resulted in the depletion of the rich resources. And hence we are in an immediate urgency to manage and the conserve the plants of medicinal origin as they are the primary subjects of human curiosity since ancient times. Thus development of advanced technology to envisage the very survival of endangered plant species is to be encouraged so as to meet the raising commercial demands.

These are some of the medicinal plants that are produced by Hydroponics system in the recent past for their bio active principles and the terrestrial parts. *Aloe vera*(Indian Aloe)^[7], *Solenostemon scutellarioides* (*Coleus*)^[7], *Anemopsis californica*(Yerba mansa)^[7], *Bacopa monnieri* (Brahmi)^[8], *Glycyrrhiza uralensis* (Chinese liquorice)^[9], *Withania somnifera*(Ashwagandha)^[10], *Urena lobata* (Congo jute)^[11], *Bupleurum falcatum* (Chinesethoroughwax)^[12] and *Glycyrrhiza glabra* (Licorice)^[13,14].

In general, Medicinal plants despite their origin and the systematic position possess a specific therapeutic nature by the substances that are chemically complex and are synthesised within their own cells. These substances are hence considered to be the vegetable active principles. The chemical nature, physiochemical property and biological action play a prominent role being the criteria's for the classification of medicinally and aromatically important plants and herbs. The significant active principles usually comprises of proteins, glucides, lipids, aminos, volatile oils, saponins, tannins, resins, organic acids, alkaloids, vegetable dyes, mineral substances, glycosides, pectins and vitamins.

The hydroponics in turn promises to be an extremely lucrative and fastest growing cultivation down the agriculture sector. Provided growing the plants under controlled conditions would in turn ensure the retention of natural bioactive compounds present in them to an extent and

thereby increase its utility in pharmaceutical industries. And it is extremely clean and easy method because there is no chance of soil-borne disease, insect or pest infection to the crops^[15]. Hence, the application of hydroponics helps us in the production of the healthiest crops and medicinal plants with high range of bioactive compounds with high yields in short period and the operation costs are comparatively much less to soil based cultivation as it does not require the major application of fertilizers, pesticides, and herbicides to grow the crops in higher quantity. As hydroponics system is free from risks and provides high production.

4. ADVANTAGES OF THE HYDROPHONICS SYSTEM

- Hydroponic cultures represent possibly the most intensive method of cultivation that is now available in the agricultural domain.
- It promotes reduced dependency on climatic factors such as light, temperature and humidity.
- Facilitates the usage of Low land area with high mass productivity.
- It helps us protect the plants or ensure reduction in soil born microbial and viral diseases.
- Also to control the growth of insect pests which in turn prevents the application of harmful insecticides.
- Productivity loss due to grazing could be avoided by indoor hydroponic systems.
- It opens up a solution for irrigation as it requires minimal water supply.
- Absence of weed prevents the usage of weedicides.

5. LIMITATIONS OF HYDROPONICS

- Cultivation of trees and tall plant varieties are pretty difficult as the technique turns to be most suitable for small herb, shrubs and climbers.
- Adequate technical knowledge and subsequent safeguarding is required^[16].
- The system requires instant supervision and managerial expertise.
- Initially the investment cost is higher for the start-ups than the cost of traditional technique.
- If any problem arises in the culture, it might lead to complete loss of plant yield. Finally, prompt light and energy are to be supplied to run the system^[17].

6. CONCLUSION

With a rapid increase in the population, the demand for the food crops and medicinal herbs are becoming higher and higher. In the interim, traditional farming may not be promising so

as to meet the growing demand. Thus to overcome the crisis, new farming methods and planting techniques are to be effectively developed. Hence, this review aimed to study the potent technique that could be used as an alternative. Thus the 'hydroponics' system would for sure open up a new door for the production of crops of medicinal importance, as the growth in a perfectly controlled atmosphere reduces the impacts of greenhouses and nurseries upon the environment^[18]. It would also ensure the production round the year thereby making an appropriate support for biological research promoting a way to critically analyse the interactions between multiples factors, both biotic and abiotic, influencing the plant growth. This system can be a versatile knowledge in both rural or town and high-tech space stations, as they are proficient practice for food cultivation from adverse environmental ecosystems such as deserts, mountainous regions, or arctic communities. The government must take initiatives to formulate the public policies as there are higher demands for the hydroponics systems in both developing and devolved countries.

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